Tools for Asteroid Regolith Operations

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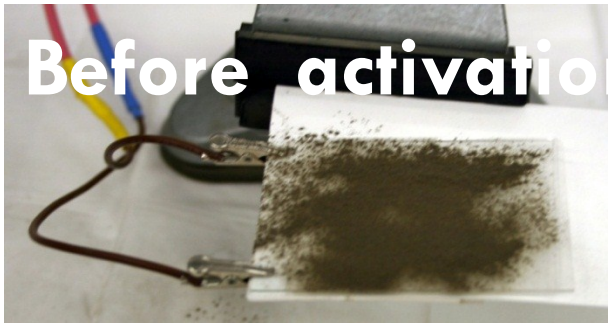
Technologies

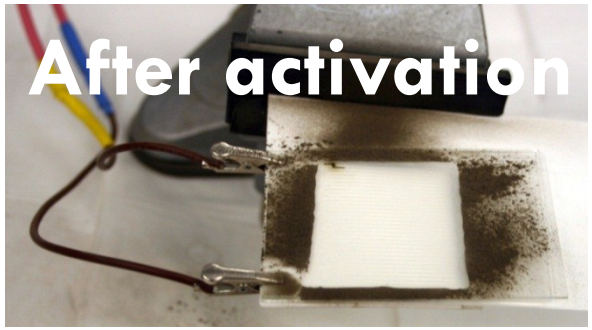
Utilizing:

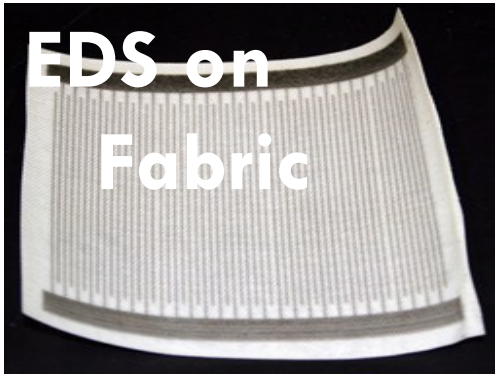
- **ELECTRODYNAMIC DUST SHIELD,**
- **PNEUMATIC REGOLITH RAKE,**
- **PERCUSSIVE EXCAVATION SHOVEL**

For Crew Asteroid Exploration

Electrodynamic Dust Shield for Asteroid Mission







- **Electrodynamic Dust Shield: Active multilayer coating that removes dust from surfaces**
  - EDS for Visors, optical devices, viewports—transparent ITO electrodes on film, plastic, or glass
  - EDS for spacesuits: CNT electrodes printed on fabric
  - EDS for thermal radiators: 1000 Å copper electrode layer on Kapton film coated with thermal paint—silver electrode layer on FEP for second surface mirrors

EDS Video

Apollo 16 dust removal at vacuum on Reduced Gravity Flight

POC: Dr. Carlos I. Calle, NASA KSC

Pneumatic Regolith Rake

SWAMP WORKS
NASA KENNEDY SPACE CENTER

Pneumatic Conveyance of Regolith (demonstrated to convey 17 kg)

Planetary Regolith Delivery Systems for ISRU

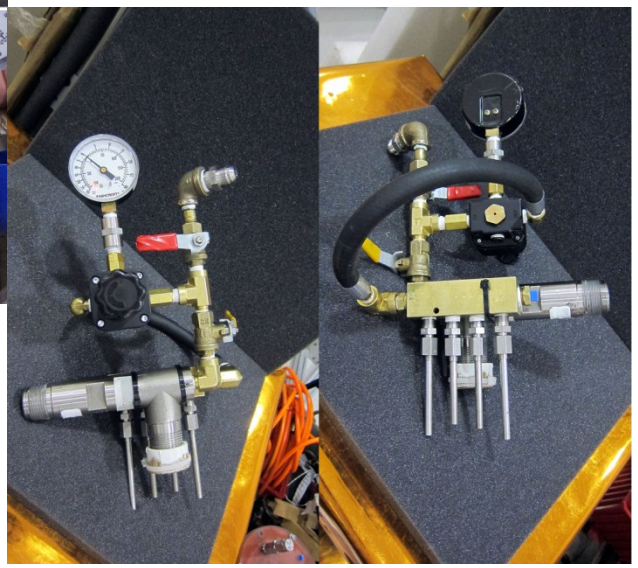
James G. Mantovani, Ph.D.[1]; and Ivan I. Townsend III[2]

Abstract: This paper describes tests conducted since 2008 at the National Aeronautics and Space Administration (NASA) Kennedy Space Center (KSC) to address engineering challenges associated with delivering planetary regolith to in situ resource utilization (ISRU) systems. The need to excavate regolith under reduced-gravity conditions on a planetary surface and then deliver it to systems for material analysis and/or processing constrains the possible engineering approaches that can be used in space. Mission costs may further limit the mass and available power of a regolith delivery system. Mechanical systems operating in a planetary environment require high reliability with respect to system service life because it is usually difficult or impossible to perform maintenance robotically on a planetary surface. The regolith delivery system for most ISRU systems must have a leak-tight interface between the near-vacuum found on a planetary surface and the pressurized atmosphere within the ISRU reactor. Depending on the mission, the amount of regolith that must be delivered may range from a few grams (e.g., for analysis) to tens of kilograms (e.g., for oxygen production). Hot, spent regolith from an ISRU reactor must eventually be returned to the planetary environment by means of an interface that is capable of operating and sealing over a potentially large temperature range. In this paper, we will describe pneumatic and auger methods of conveying large amounts of regolith that have been studied and demonstrated at NASA KSC and at ISRU field tests and discuss other regolith delivery systems that are being designed for future field tests. **DOI:** 10.1061/(ASCE)AS.1943-5525.0000248.

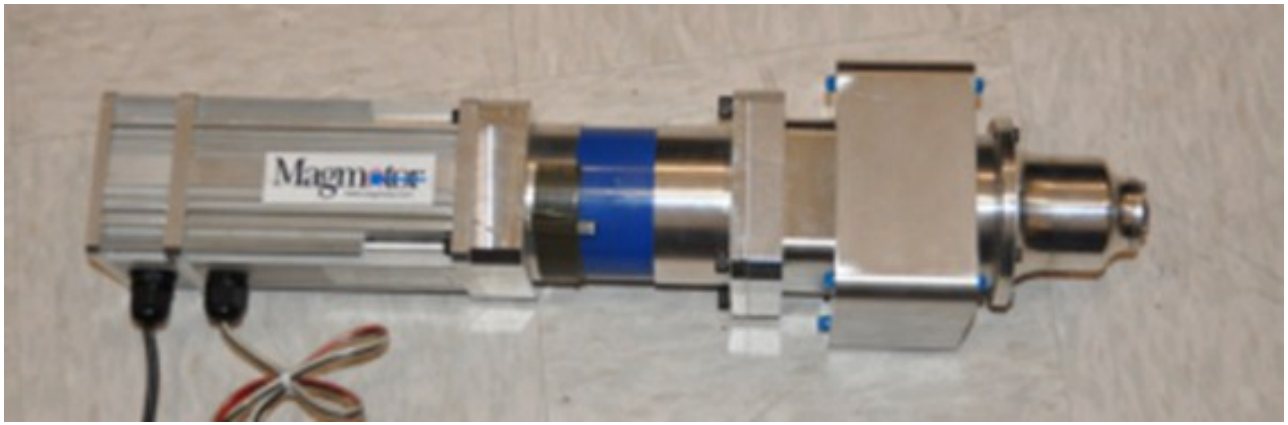
CE Database subject headings: Planets; Soils; Natural resources; Space exploration; Field tests.

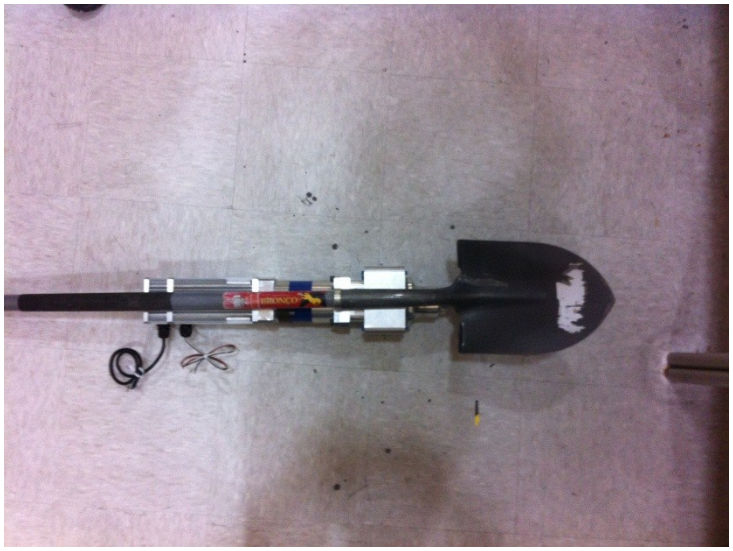
Author keywords: ISRU; Planetary regolith; Regolith delivery system.

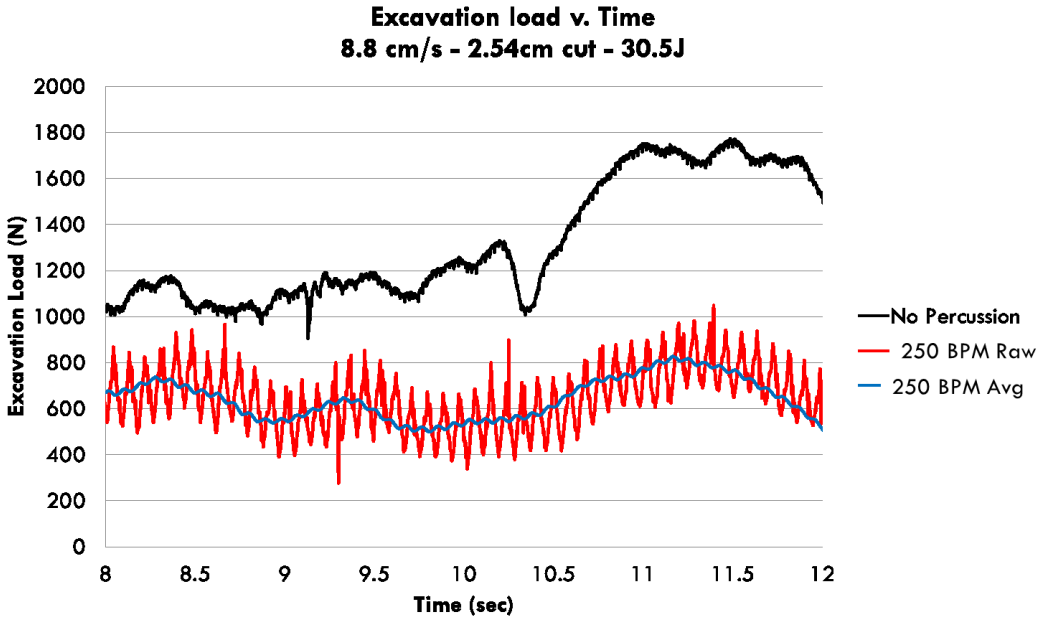
Pneumatic Excavation and Acquisition of Regolith



Percussive Excavation Shovel







Conclusion

- Astronauts working with Asteroid regolith will need protection from dust and dust mitigation for payloads and instruments
- ***The Electrodynamic Dust Shield is at TRL 6 and available for mission infusion***
- Astronauts collecting dust will need tools that facilitate the operation while increasing his/her work capacity
- The Pneumatic Regolith Rake allows the crew to collect loose surface regolith from a distance – application possible for ARM sample collection
- ***The Pneumatic Regolith Rake is at TRL 3***
- The Percussive Excavation Shovel allows trenching and deep regolith sample collection by an astronaut on an asteroidal surface with reduced reaction forces
- ***The Percussive Excavation Shovel is at TRL 4***
- Please contact the NASA KSC Surface Systems Office for more information